ISSN: 2146 - 9466
www.ijtase.net
International Journal of New Trends in Arts, Sports &Science Education - 2014, volume 3, issue3

DETERMINATION OF MISCONCEPTIONS BELONGING TO THE "SOLAR SYSTEM AND BEYOND: SPACE PUZZLE" UNIT IN 7 TH GRADE SCIENCE AND TECHNOLOGY CURRICULUM WITH TWO-TIER DIAGNOSTIC TESTS

Öğr. Gör. Ufuk TÖMAN
Bayburt University, Faculty of Education, Bayburt, Turkey
utoman@bayburt.edu.tr

Yusuf ERGEN
Bayburt University, Faculty of Education, Bayburt, Turkey
yergen@bayburt.edu.tr

ABSTRACT
Today's World is in period of rapid development of science and technology. There is science and technology education that not based on rote, practical on the basis of development in science and technology. Misconceptions are a major obstacle in order to take the desired efficiency. Because concepts that learned wrong obstacle attainment of right to information and thus prevent production of the right information. The purpose of this article; using two-stage diagnostic tests is to reveal student's misconception how to exhibit and student's misconceptions are to exhibit " The Solar System and Beyond: Space Enigma" unit of instructional program of Science and Technology lesson of 7th. grade elementary school. The standard testing methods from the descriptive research methods was used ın this study. In result of the research students have some of misconceptions have been identified by two-stage diagnostic test.
Keywords: Science and Technology, Misconceptions, Two-Stage Diagnostic Test.

1. Introduction

Countries make great efforts to keep up with the developments in the changing and developing world. When in which fields studies must be carried out in order to keep up with the developments and go a step further is considered, it is difficult to distinguish one area from another (Schulte, 2001). However, as many fields, from medicine to astronomy, are based on science and technology education, educators must pay more attention to science and technology education and they must be more sensitive and self-denying in this field. Basic education is particularly a place where a child learns what the teacher teaches and what is obtained in the end. When this stage is explored, it is revealed that one of the main courses which students have difficulty in understanding is science. So, a question which needs to be considered is what we must do to have the students like science courses (Köse, Ayas and Taş, 2003).

The main purpose of science and technology course is to raise individuals who do not feel the need to be manipulated and shaped, interpret, use, and generate the knowledge but not in the way it is presented (Yıldırım ve Şimşek, 2011). Science education has an important place in primary schools where the children aged between 6 and 14 continue their education in our country where a need for qualified labour force gradually increases (Korkmaz, 2002).

Science education is the instruction of attractive and amazing richness in child's environment. It is the instruction of the food a child eats, the water he drinks, the air he breathes, his body, the animal he feeds, the car he gets into, and the electricity, light and sun he uses. Therefore, science education is a concrete instruction which must be carried out with appropriate methods and techniques by taking into account the child's needs and interests, development level, desires, and environmental facilities (Hırça and et al., 2008).

Today is the age where many advances in information and technology field are experienced and new developments will emerge depending on these advances. If societies have the existing knowledge and technology, they may undoubtedly benefit from the generated knowledge and technology at the

highest level and in the cheapest way in this age, which is also called information and technology age (Şahan and Tekin, 2007). This condition requires qualified labour force. In order to raise qualified people in science and technology field, science and technology education should be given to people with appropriate methods and techniques, enough practices, and it must be based on scientific facts beginning from primary education level. The child should not have difficulty transferring what they learned at school into life. Therefore, what must be paid attention is that the knowledge, skills and attitudes taught at school must be necessary for life because people who transfer knowledge and use it, know how to learn knowledge, reach real knowledge and solve troubles are required (Berber and Sarı, 2009; Şahan and Tekin, 2007).

Concepts are very important for science and technology course as with the other courses. We name the phenomenon with concepts and we make generalizations with concepts. Thus, the meanings of concepts and their use must be paid attention (Köse, Ayas and Taş, 2003). Children begin school after learning some concepts informally. Whether these concepts are scientifically true or not, or whether they are used correctly or not are determined by the teachers at schools and necessary corrections are made. However, misconceptions which we frequently encounter in daily life indicate that concept learning in schools is not adequate or misconceptions are not corrected (Töman, 2010; Yağbasan and Gülçiçek, 2003). Students construct their opinions and develop them by using their experiences in daily life. They try to explain the events taking place around them based on their knowledge. Unfortunately, unlike scientific opinions, their opinions mostly differ in many aspects. Thus, alternative conceptions developed by the students are very important with regard to education because these hinder learning considerably (Palmer, 1998; Palmer, 2001). In order to eliminate misconceptions within the students, firstly misconceptions must be determined. In addition to the methods such as concept maps, drawings, word associations used to determine the misconceptions within the students, two-tier diagnostic tests are used to determine misconceptions (Karataş, Köse and Coştu, 2003; Oliva, 1999). If a student has a misconception, its reasons are tried to be probed with two-tier diagnostic tests where a second stage supplying reasons for student's choice of option is put into the multiple choice tests. *Two-tier diagnostic tests* which have the positive aspects of the multiple choice tests but also eliminate the negative aspects of the multiple choice test to the minimum were developed in 1980s and they have been widely used by many researchers in different science fields for the last 10-15 years (Anderson, Fisher and Norman, 2002; Atasoy and Akdeniz, 2007; Chen, Lin and Lin, 2002; Demircioğlu, 2003; Tan and et al., 2002).

Two-tier tests have various types and types can be divided into three forms:
1- Two-tier multiple choice tests
2- Two-tiered classification tests
3- Open-ended two-tiered tests

The first tier of these tests is usually like the multiple choice tests. In other words, it consists of an item or a content knowledge and options for the questions. Two-tier tests differ from multiple choice tests with regard to their second tier. The second tier elicits a reasoning response from the students for all potential selected responses for the first tier. . The second tier of the test is composed of multiple-choice or open ended-multiple choice questions (only one answer allowed) consisting of students' alternative conceptions (misconceptions) determined depending on the findings obtained from the relevant literature or interviews. Moreover, the second tier consists of open-ended questions to detect whether there are different alternative concepts existing from the misconceptions determined previously or not and measure students' reasoning abilities better (Briggs, Alonzo, Schwab and Wilson, 2006; Mann & Treagust,2010; Oliva, 1999). "*Two-tier Diagnostic Test requiring Classification*" was used in the study which aims at determining the students' misconceptions belonging to the "*Solar System and Beyond: Space Puzzle*" unit of 7th grade primary Science and Technology course.

2. Purpose

The purpose of the study is to reveal how to detect students' misconceptions using two-tier diagnostic tests and determine students' misconceptions belonging to the "*Solar System and Beyond: Space Puzzle*" unit of 7th grade primary Science and Technology curriculum.

3. Method

The research is a descriptive study. Descriptive research design is used to describe what is in existence without changing the environment of the situation to be studied (Çepni, 2009). Standardized test method, one of the descriptive research designs, was used in the research. Standardized test method is assessment of the individuals' behaviours and attitudes via a set of written or oral questions which have been standardized for everyone about a specific behaviour including the same content, implementation, processes taken during the implementation, time, and assessment criteria (Yıldırım and Şimşek, 2011).

Two-tier diagnostic test requiring classification, developed by the researcher about the "*Solar System and Beyond: Space Puzzle*" unit of 7th grade primary Science and Technology curriculum, was used in the research as a data collection tool. The researcher took into account the goals and objectives of the course curriculum for this test and a concept map related to the unit was developed. The concept map was analysed by two teachers from the field and two faculty members and then necessary changes were made. A test consisting of 25 open ended questions were administered to 37 students in Manisa to determine students' understandings about the concepts in the unit. Common misconceptions were determined and considering these misconceptions, 14 statements and 14 questions related to these statements and consisting of "true" and "false" options were developed. After each question the conjunction "because" was used and the test was administered with the same students. The students were asked to justify their reasons for the chosen options. With reference to students' justifications, the number of items in the test was reduced to 8 items and the second tier of the test was developed as a multiple choice test consisting of the correct answers and the common misconceptions. The reliability of the test was calculated using the Sperman Brown formula and it was found to be r=0,72.
The research was conducted by the participation of 7th grade students at primary schools. The population of this study was composed of 80 students selected from primary schools in Malatya and Manisa.

4. Findings and Discussion

Eight statements given to the students about the unit and the responses of the students to these statements in the two-tiered classification test were interpreted in the tables given below.
According to the evaluation of the two-tiered classification tests, in case an incorrect response is given to either one of the two tiers existing for each statement, the overall question is considered wrong.

1st Statement: Looking at the colours of the stars, we can get information about their temperature.

Tier I		**Tier II**		**Overall**	
T	**F**	**T**	**F**	**T**	**F**
72	8	60	20	60	20
%90	**%10**	**%75**	**%25**	**%75**	**%25**

f: 80

T: Correct answer **F:** Wrong answer

Because 75 % of the students gave correct answers in both tiers, they did not have misconceptions about the statement "Looking at the colours of the stars, we can get information about their temperature". However, 10 % of the students gave incorrect answers in the first tier and 25% of them answered incorrectly in the second tier.

As stated above, the overall question is considered incorrect when an incorrect option is chosen for either one of the two tiers in two-tiered classification tests. As it is presented in the overall section of the table, 25% of the students have misconceptions about the statement "Looking at the colours of the stars, we can get information about their temperature". Moreover, this situation reveals that the students who made mistakes mostly made mistakes in the second tier, in other words, in the justification part.

2nd Statement: Zodiac signs are the names given to constellations. Human beings share some common traits resulting from the stars forming the zodiac signs and the effects caused by the planets passing through the zodiac signs.

Tier I		**Tier II**		**Overall**	
T	**F**	**T**	**F**	**T**	**F**
64	16	56	24	46	24
%80	**%**20	**%**70	**%**30	**%**70	**%**30

f: 80

T: Correct answer **F:** Wrong answer

Because 70 % of the students gave correct answers to both tiers, they did not have misconceptions about the statement "Zodiac signs are the names given to constellations. Human beings share some common traits resulting from the stars forming the zodiac signs and the effects caused by the planets passing through the zodiac signs". However, 20 % of the students gave incorrect answers in the first tier and 30 % of them gave incorrect responses in the second tier. As stated above the overall question is considered wrong when a wrong option is chosen for either one of the two tiers in two-tiered classification tests. As it is presented in the overall section of the table, 30 % of the students have misconceptions about the statement "Zodiac signs are the names given to constellations. Human beings share some common traits resulting from the stars forming the zodiac signs and the effects caused by the planets passing through the zodiac signs". Moreover, this situation reveals that the students who made mistakes mostly made mistakes in the second tier, in other words, in the justification part.

3rd Statement: A shooting star is the movement of the stars in the sky from one place to another.

Tier I		**Tier II**		**Overall**	
T	**F**	**T**	**F**	**T**	**F**
72	8	40	40	32	48
%90	**%**10	**%**50	**%**50	**%**40	**%**60

f: 80

T: Correct answer **F:** Wrong answer

Because 40 % of the students gave correct answers in both tiers, they did not have misconceptions about the statement "A shooting star is the movement of the stars in the sky from one place to another". However, 10 % of the students answered incorrectly in the first tier and 50 % of them gave incorrect responses in the second tier. This situation reveals that the students who gave incorrect responses mostly made mistakes in the second tier in which they would justify their reasons. As it is understood in the "overall" section of the table, the students who gave incorrect answers in either one of the two tiers of the question compose 60% of the total number of students. Thus, this suggests that 60% of the students, in other words more than half of the students, have misconceptions about the statement "A shooting star is the movement of the stars in the sky from one place to another".

4th Statement: Planets and stars are the same. Because planets are merely larger than stars, they are called planets.

Tier I		Tier II		Overall	
T	F	T	F	T	F
63	17	56	24	39	41
%79	%21	%85	%15	%49	%51

f: 80

T: Correct answer **F:** Wrong answer

As it is revealed in the table, while 49 % of the students gave correct answers to both tiers, 79 % of them gave correct answers in the first tier and 85 % of them gave correct responses in the second tier. However, 21 % of the students gave incorrect answers in the first tier and 15 % of them gave incorrect responses in the second tier. This situation indicates that most of the students made mistakes in the first tier of the question. As it is understood in the "overall" section of the table, 51% of the students gave incorrect answers in either one of the two tiers of the question. This situation reveals that 51 % of the students, nearly half of them, have misconceptions about the statement "Planets and stars are the same. Because planets are merely larger than stars, they are called planets".

5th Statement: A tidal phenomenon which occurs twice per day in the seas is due to the gravitational forces of the Earth and the Moon acting upon each other.

Tier I		Tier II		Overall	
T	F	T	F	T	F
76	4	72	8	72	8
%95	%5	%90	%10	%90	%10

f: 80

T: Correct answer **F:** Wrong answer

While 95 % of the students answered correctly to the first tier of this question, 90% of the students responded correctly to the second tier. 5% of the students gave incorrect responses in the first tier and 10% of them gave incorrect responses in the second tier. This reveals that 90% of the students answered the question correctly and they did not have misconceptions about the statement. On the other hand, as 10% of the students responses incorrectly in either one of the two tiers of the question, it can be stated that they had misconceptions about the statement.

6th Statement: The width of the sun is much larger than all the galaxies existing in the space.

Tier I		Tier II		Overall	
T	F	T	F	T	F
68	12	60	20	52	28
%85	%15	%75	%25	%55	%35

f: 80

T: Correct answer **F:** Wrong answer

85 % of the students answered correctly in the first tier of this question and 75 % of the students responded correctly in the second tier. 55% of the students gave correct answers in both tiers of the question. It is suggested that 55% of them did not have misconceptions about the statement "The width of the sun is much larger than all the galaxies existing in the space". However, because 35 % of them gave incorrect answers in the first and the second tier of the question, they had misconceptions about the statement.

7th Statement: Space suits which astronauts wear in the space provide oxygen, suitable atmosphere for their body temperature, and protect them against radiation.

Tier I		Tier II		Overall	
T	**F**	**T**	**F**	**T**	**F**
69	11	57	23	48	32
%66	**%14**	**%51**	**%29**	**%60**	**%40**

f: 80

T: Correct answer **F:** Wrong answer

As presented in the table, 66% of the students answered correctly in the first tier of the question and 51% of them responded correctly in the second tier. 60% of the students gave correct answers in both tiers which reveal that 60 % of them did not have misconceptions about the statement "Space suits which astronauts wear in the space provide oxygen, suitable atmosphere for their body temperature, and protect them against radiation". However, because 40 % of them gave incorrect responses in the first or the second tier of the question, they had misconceptions about the statement.

8th Statement: Space pollution is the formation of a polluted air layer in the space which is comprised of the smog from the factories, the exhaust system, stoves and central heating systems in the world.

Tier I		Tier II		Overall	
T	**F**	**T**	**F**	**T**	**F**
63	17	47	33	38	42
%79	**%21**	**%59**	**%41**	**%47**	**%53**

f: 20

T: Correct answer **F:** Wrong answer

As understood from the table, 79% of the students answered correctly in the first tier of the question and 47% of them responded correctly in the second tier. While 21% of the students gave incorrect answers in the first tier, 41% of them gave incorrect responses in the second tier. When the question is evaluated, it is found that 47% of the students gave correct answers in both tiers. However, as 53% of them gave incorrect answers tin either one of the two tiers or both of them, it was understood from the table that they answered the question incorrectly. This reveals that 53% of the students had misconceptions about the statement "Space pollution is the formation of a dirty air layer in the space which is comprised of the smog from the factories, the exhaust system, stoves and central heating systems in the world".

5. Conclusion and Suggestions

The results of the research revealed that the 7th grade students participating in the study had some misconceptions about the "*Solar System and Beyond: Space Puzzle*" unit of 7th grade primary Science and Technology curriculum and these misconceptions were determined by the two-tier diagnostic test. According to the results obtained from the research, out of the 8 statements in the test, the students gave more incorrect responses only in the first tier of the question about the statement "Planets and stars are the same. Because planets are merely larger than stars, they are called planets" than the second tier. The rate of the students who responded incorrectly in the second tier was higher with the questions belonging to other statements. This situation reveals that the students had made mistakes while explaining the reasons for the given statements and they had misconceptions because they did not know the reasons for the statement.

When the general evaluation of the questions belonging to the statements "A shooting star is the movement of the stars in the sky from one place to another", "Planets and stars are the same. Because planets are merely larger than stars, they are called planets", and "Space pollution is the formation of a

dirty air layer in the space which is comprised of the smog from the factories, the exhaust system, stoves and central heating systems in the world" in the test were considered, more than half of the students answered the questions incorrectly. This situation indicates that more than half of the students had misconceptions about the relevant statements.

"Two-tier Diagnostic Tests" can be used to determine misconceptions. Teachers should practise activities which will reveal the students' analysis and synthesis skills during the instruction in order to eliminate the specified misconceptions. Moreover, misconceptions may be resulting from students' prior learning. Teachers must control students' prior learning before the course and if there are misconceptions which need to be corrected, they must try to eliminate those facilitating students with concrete examples as far as possible and including more practice activities. Otherwise, students will have difficulties in creating new learning schema or they will form schema including incorrect knowledge. Teachers can benefit from analogies, use concept maps, include group discussions in the lessons, and use refutation texts to eliminate misconceptions.

6. References

Anderson, D.L., Fisher, K.M., ve Norman, G.J. (2002). "Development and evaluation of the conceptual inventory of natural selection". Journal of research in science teaching. Cilt: 39, Sayı: 10. (952-978).

Atasoy, Ş ve Akdeniz, A. R. (2007). Newton'un Hareket Kanunları Konusunda Kavram Yanılgılarını Belirlemeye Yönelik Bir Testin Geliştirilmesi ve Uygulanması. Türk Fe Eğitimi Dergisi, 4(1).

Berber, N. ve Sarı, M. (2009). Kavramsal Değişim Metinlerinin İş, Güç, Enerji Konusunu Anlamaya Etkisi, Selçuk Üniversitesi Ahmet Keleşoğlu Eğitim Fakültesi Dergisi, 27, 159-172.

Briggs, D.C., Alonzo, A.C., Schwab, C., ve Wilson, M. (2006). Diagnostic assessment with ordered multiple-choice items. Educational Assessment. Cilt: 11 Sayı: 1. (33-63).

Chen, C. C., Lin, H. S., ve Lin, M.L. (2002). "Developing a two-tier diagnostic instrument to assess high school students' understanding-the formation of images by a plane mirror". Proceedings of the National Science Council, 12(3), 106-121.

Çepni, S. (2009). Araştırma ve Proje Çalışmalarına Giriş, 4. Baskı, s.64, 2009, Trabzon.

Demircioğlu, G. (2003). Lise II Asitler ve Bazlar Ünitesi İle İlgili Rehber Materyal Geliştirilmesi ve Uygulanması. KTÜ Fen Bilimleri Enstitüsü, Yayınlanmamış Doktora Tezi, Trabzon.

Hırça, N., Çalık, M. ve Akdeniz, F. (2008). Investigating grade 8 students' conceptions of energy and related concepts, Journal of Turkish Science Education, 5, 1, 75-85.

Karataş, F.Ö., Köse, S., Çoştu, B. (2003). Öğrenci Algılarını ve Anlama Düzeylerini Belirlemede İki Aşamalı Testler, Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, Sayı 13, 2003.

Korkmaz, H. (2002), Fen Eğitiminde Proje Tabanlı Öğrenmenin Yaratıcı Düşünme, Problem Çözme ve Akademik Risk Alma Düzeylerine Etkisi. Yayınlanmamış Doktora Tezi. Ankara: Hacettepe Üniversitesi Sosyal Bilimler Enstitüsü.

Köse, S., Ayas A. ve Taş, E. (2003). Fen Bilgisi Öğretmen Adaylarında Fotosentez ve Bitkilerde Solunum Konularında Görülen Kavram Yanılgılarının Giderilmesinde Kavram Değişim Metinlerinin Etkisi, Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 14, 106-112.

Mann, M. ve Treagust, F. D.(2010). Students' conceptions about energy and the human body, Science Education International, 21(3),144-159.

Oliva, J. M. (1999). Structural Patterns in Students' Conceptions in Mechanics. International Journal of Science Education, 21 (9): 903-920.

Palmer, D. H. (1998). Measuring Contextual Error in the Diagnosis of Alternative Conceptions in Science, Issues in Educational Research, 8, 1, 65-76.

Palmer, D. (2001). Students'Alternative Conceptions and Scientifically Acceptable Conceptions About Gravity, International Journal of Science Education, 23, 7,691-706.

Schulte, P. L. (2001). Pre Service Primary Teacher Alternative Conceptions in Science and Attitudes Toward Teaching Science, Unpublished Doctoral Dissertation, New Orleans University, New Orleans.

Şahan, B.Y. ve Tekin, L. (2007). Ortaöğretim 10. Sınıf Fizik Ders Kitabı. İzmir: Zambak Yayınları.

Tan, K. C. D., Goh, K. N., Chia, S. L. ve Treagust, D. F. (2002). Development and Application of a Two-Tier Multiple Choice Diagnostic Instrument to Assess High School Students' Understanding of Inorganic Chemistry Qualitative Analysis, Journal of Research in ScienceTeaching, 39, 4, 283-301.

Töman, U ve Saka, A. (2010). Enerji kavramı ile ilgili öğrenci görüşlerinin yaşlara göre değişimi. IX. Ulusal Fen ve Matematik Eğitimi Kongresi. İzmir.

Yağbasan, R., ve Gülçiçek, G. (2003). Fen Öğretiminde Kavram Yanılgılarının Karakteristiklerin Tanımlanması, PAÜ Eğitim Fakültesi Dergisi, 13, 110-128.

Yıldırım, A, Şimşek, H.(2011). Nitel Araştırma Yöntemleri. Ankara: Seçkin Yayınevi.